

LIFE-FORM SPECTRA OF THE MUDFLAT FLORA ON THE SCIOTO RIVER, DELAWARE COUNTY, OHIO

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ABSTRACT

Raunkiaer's life-form designations were used to produce several spectra for the flora of a recently exposed mudflat located on the Scioto River, Delaware County, Ohio. These spectra contain a high percentage of hemicryptophytes, which confirms previous life-form studies of eastern North American floras. However, the high percentage of therophytes (annual plants) in the spectra of a mudflat flora has not previously been reported for this phytoclimatic region, and suggests that localized factors such as disturbance may play a significant role in the determination of life-forms in specific habitats. Altering Raunkiaer's method to include species abundance values had little impact on the resulting spectra calculated for the mudflat flora.

INTRODUCTION

Botanists long have recognized certain specific life-forms in plants (e.g., trees, shrubs, herbs, etc.) but not until the early 20th century were attempts made to study plants as forms produced by their environment (Cain 1950). The Danish botanist Eugenius Warming devised a system that categorized plants according to a "growth-form" (Warming 1909). This complex system placed emphasis on six separate characters, and proved to be too complicated for practical application (Adamson 1939; Cain 1950). Christen Raunkiaer, the successor to Warming as Professor of Botany at the University of Copenhagen, believed something was missing from earlier growth-form schemes, namely that none of them provided a correlation between the vegetation of an area and the associated climate. He devised a life-form classification that relied solely on the position of the perennating buds (growing points) during the least favorable environmental conditions, when the plant was "at rest" (Raunkiaer 1934). Earlier researchers probably placed too much emphasis on the importance of this system. For this reason, Raunkiaer's life-form classification system became unpopular and was neglected for many years (Cain 1950). Since the 1960s, however, life-form studies

have been conducted on the plants of Kentucky (Gibson 1961), Mackenzie in Northwest Territory (Thieret 1963), Minnesota (Thieret 1967), Michigan (Thieret 1977), Ohio (Luken & Thieret 1988), and Israel (Danin & Orshan 1990).

In using Raunkiaer's life-form classification, most investigations in North America have examined the flora of entire regions and produced a life-form spectrum for a particular region. A life-form spectrum is the percent composition in the flora for each of Raunkiaer's five main life-form classes, which can be simplified as follows (Raunkiaer 1934):

1) **PH** (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.

2) **CH** (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.

3) **HE** (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.

4) **CR** (Cryptophytes) = Perennating buds protected below soil surface or under water.

5) **TH** (Therophytes) = Annual plants, which survive unfavorable conditions as seeds.

Broad comparisons of life-form or "biological" spectra over different climates and community types may be used to test the hypothesis that, in general, a plant's vegetative body is a result of the broad climatic conditions in which it lives.

Raunkiaer believed that the world can be divided into four major "phytoclimates" (Raunkiaer 1934):

1) **Phanerophytic**—warm, humid tropics

2) **Hemicryptophytic**—deciduous and needle-leaved forests

3) **Therophytic**—tropical and subtropical deserts

4) **Chamaephytic**—high latitudes and altitudes

As a base-line model to be used as a comparison, Raunkiaer devised a "normal spectrum" for the five life-form classes. This "normal spectrum" included 400 species, and was an attempt to devise a phytoclimatic spectrum for the whole planet (Smith 1913). Many of the life-form spectra completed in this country for large regions have tended to support Raunkiaer's hypothesis that the eastern United States belongs in the hemicryptophytic phytoclimate (Table 1).

It has been suggested that more life-form studies should be conducted, especially in specific habitats (Gibson 1961; Thieret 1977). Some of the habitats previously studied in relation to their life-form spectra include Minnesota hardwoods (Buell & Wilbur 1948), Minnesota jack pine forests (Stern & Buell, 1951), New Jersey pine barrens (Stern & Buell 1951), and the Smoky Mountains (Cain 1945). So far as we know, no life-form spectrum has been calculated for a river mudflat flora. An extensively exposed river mudflat along the Scioto River in Delaware County, Ohio, was available for this type of study.



FIG. 1. Rosette of *Rorippa palustris*, an example of a hemicryptophyte on a newly exposed Scioto River mudflat, Delaware County, Ohio. Photo October 1990 by Brian D. Gara.

STUDY SITE

The area studied was a short portion of the Scioto River north of the city of Columbus, Ohio. The mudflat is located directly across from Oller Cemetery on State Route 257, approximately 1.5 km south of the intersection with U.S. route 42. This section of the Scioto River, at the northern end of the O'Shaughnessey reservoir, was artificially drawn down in August 1989 to facilitate construction on the O'Shaughnessey Dam, 9 km downstream. The second author first noticed

TABLE 1: Life-form spectra of native species for selected geographic regions in North America.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Connecticut (Ennis 1928)	1453	15.0	1.9	49.4	21.7	11.7
Gaspé Peninsula and Bic, Quebec (Scoggan 1950)	933	12.1	9.0	49.0	22.1	7.5
Illinois (Hansen 1952)	1734	15.5	1.6	50.2	19.8	12.9
Indiana (McDonald 1937)	1837	15.3	1.7	50.3	19.6	13.0
Iowa (McDonald 1937)	1320	14.8	1.0	48.6	20.9	14.2
Kentucky (Gibson 1961)	1620	17.6	1.4	52.6	16.6	11.8
Michigan (Thieret 1977)	1608	14.2	2.2	51.6	22.1	9.2
Minnesota (Thieret 1967)	1527	13.0	3.0	49.0	22.0	13.0
Ohio (Luken and Thieret 1988)	1730	15.3	1.6	50.0	20.6	12.5

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

the exposed mudflat in September 1990. This site is several hundred meters in width and approximately 1 km long (Fig. 2). According to the Public Information Director for the City of Columbus' Water Division these river sediments had not been exposed by such a drawdown since 1952 (Jackie England, pers. comm.). The dam was re-opened in spring 1991, returning the water to previous levels (i.e., the mudflat is no longer exposed).

METHODS

The identification of each species at the study site was completed during September and October 1990. Nomenclature is according to Kartesz and Kartesz (1980); identification of plants was carried out using Fassett (1957) and Weishaupt (1971). These plants were also compared with specimens in The Ohio State University Herbarium. Several unidentified species had not yet flowered or fruited, and these were transplanted into pots in the OSU Plant Biology Department greenhouse to allow them to complete their life cycle. The com-

pleted list of identified species was arranged in tabular form (Appendix I). The Raunkiaer life-form designation was determined for each species by examining the plants in the field. Each species designation was confirmed with its description in Fernald (1950), and in other life-form studies for regions with a flora similar to Ohio: Indiana (McDonald 1937), Kentucky (Gibson 1961), Connecticut (Ennis 1928), and the Cincinnati region (Withrow 1932). Fernald (1950) was also consulted to determine each species' native or alien status. These mudflat species were also noted as occurring in "wetland" or "upland" situations, a habitat characterization according to Reed (1988). A general estimate of abundance was made for each species from observations made from September to December 1990 (Appendix I). Earlier observations (April-August) may have yielded different values as to species abundances since some species are undoubtedly more prevalent earlier in the year. We have used abundance values for species to refine the life-form spectrum of this mudflat in two ways:

- 1) A life-form spectrum was determined for those species that were "common" or "abundant" in the Scioto mudflat community. The rationale for this method was that the less common species ("occasional" and "rare") were relatively unimportant in this ecosystem and therefore could be eliminated without losing much information.

- 2) Each species was "weighted" based on these abundance values. An abundant species was counted four times, common species three times, occasional species two times, and rare species one time. This method acknowledges the discrepancy in importance for the different species based on their abundance and attempts to account for these differences by weighting each species according to these broad abundance categories.

RESULTS AND DISCUSSION

A river mudflat is usually represented by a narrow band a few meters in width, or as a shallow island that appears or disappears depending on cyclic water-level fluctuations. Our study site was much larger than a typical river mudflat in Ohio. The narrow zone where several species must compete for limited space suddenly was expanded over 100 m across the river bottom. Most of the species colonizing this mudflat emerged from a rich seed bank within the river sediments.

On this mudflat 127 species were recorded. Of these, 90 (70.9%) are native, and 37 (29.1%) are alien. Examination of the habitat classification of these species provides some useful information concerning the biology of this study site (Table 2). A majority of all the species (56.7%) are considered to be either obligate wetland or facultative wetland. Comparison of the native versus alien species shows that most of the native ones (76.7%) are considered "wetland" species ("facultative" or "obligate" wetland), whereas a majority of the alien species (78.3%) are non-wetland or "upland" species ("facultative" or "obligate" upland). This information suggests that two different processes have produced the flora on



FIG. 2. View of Scioto River showing extensive mudflat flora in the foreground and a narrow flowing water zone in the background. Photo October 1990 by Ronald L. Stuckey.

this mudflat. The substrate at this site consists of riverbed sediments, and the species present within the seed bank are the native wetland species that usually grow on the narrow wetland located between the river itself and upland habitats. Once the sediments are exposed as mudflats, many of these seeds germinate, resulting in a flora primarily of native wetland plants. As this mudflat became drier, the site came to resemble a garden or cultivated agricultural field. Because of these changes in the substrate, "weedy," usually wind-dispersed species, more typical of drier habitats, germinated and became established.

Results similar to these on the Scioto River mudflat have been recorded by Bartolotta (1978) for the flora of newly constructed dikes in the marshes of western Lake Erie. Observations during the first year growing season indicated that these new dikes were covered with native wetland species, such as *Polygonum lapathifolium*. These plants emerged from the seed bank located within the sediments used to build the dikes. By the fourth year, the vegetation at the moist base of the dikes still consisted mainly of native species, or 81.5% (53 of 65). Most of these native species, 77.4% (41 of 53), were of wetland habitats. Conversely, at the drier tops of the dikes, only 44.2% (34 of 77) of the species were native. A majority of the alien species colonizing the dike tops, 83.7% (36 of 43) were of upland habitats. The upland alien species presumably entered this habitat via wind dispersal of their seeds or fruits. These data support our findings in the Scioto

TABLE 2: Habitat classification for species present in fall 1990 on a mudflat of the Scioto River, Delaware County, Ohio.

	Sp #	OBL%	FACW%	FAC%	FACU%	UPL%
Native Species	90	40.0	36.7	10.0	8.9	4.4
		76.7				
Alien Species	37	2.7	5.4	13.5	45.9	32.4
					78.3	
Total Species	127	29.1	27.6	11.0	19.7	11.9
		56.7				

+ indicates that the species is toward the upper end of this range.
- indicates that the species is toward the lower end of this range.

OBL (Obligate Wetland) = Species occurring in wetlands greater than 99% of the time.
FACW (Facultative Wetland) = Species occurring in wetlands between 67% and 99% of the time.
FAC (Facultative) = Species occurring in wetlands 34% to 66% of the time.
FACU (Facultative Upland) = Species occurring in upland habitats between 67% and 99% of the time.
UPL (Obligate Upland) = species occurring in uplands greater than 99% of the time.
(Habitat Classification after Reed 1988)

River mudflat flora, and the contention that as the habitat becomes drier, native wetland species become less common within the flora, while upland alien species migrate in and become more prevalent.

Life-form spectra were calculated for all species, native and alien, on this mudflat. These spectra are compared with each other and with other spectra compiled for specific habitats in the United States (Table 3). The high hemi-cryptophyte component occurring on this mudflat correlates well with previous studies from other localities in eastern United States. The most striking aspect of this mudflat spectrum is the high percent of therophytes. Values this high have not previously been recorded in any life-form spectrum for eastern and midwestern United States (Tables 1 and 3). Perhaps an explanation for this high percentage is that most, if not all, previous studies have been conducted on forest communities, or over large geographic regions composed mainly of upland communities. The effect of small, “disturbed” sites such as river mudflats or similar wetland habitats involving extensive floristic studies would probably be diluted by the enormous proportion of species in more stable habitats. One way to determine the ecological significance of these disturbed areas is to examine their life-form spectra.

Analysis of the alien floristic component of a large geographical area with respect to its life-form spectrum would be another way to examine the effect of disturbance on plant life-forms. For the most part these “alien” species have evolved in areas of human disturbance in the Old World and have colonized North America only where similar sites of disturbance have been artificially created here. Warming had criticized Raunkiaer’s work, claiming that the effect

TABLE 3: Life-form spectra of native and alien species for selected locations in North America.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat –all species	127	6.3	1.6	41.7	10.2	40.2
Scioto River Mudflat –native	90	7.8	1.1	41.1	13.3	36.7
Scioto River Mudflat –alien	37	2.7	2.7	43.2	2.7	48.7
Minnesota Hardwoods (Buell and Wilbur 1948)	145	35.9	2.8	44.1	17.2	0.0
Smoky Mountains National Park (Cain 1945)	1142	19.5	1.7	52.1	15.1	11.5
New Jersey Pine Barrens (Stern and Buell 1951)	19	84.2	0.0	10.5	5.2	0.0
Bacon’s Swamp, Indiana (Phillips 1929)	164	43.3	1.8	22.6	29.9	2.4
Plains Flora, S. Mackenzie, NWT Canada (Thieret 1963)	558	11.3	7.3	53.8	17.7	9.8
Hydrophytic Community, Cincinnati, Ohio (Withrow 1932)	35	8.6	2.9	31.4	40.0	17.1

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

of non-indigenous species was not considered in his classification scheme (Warming 1908, translated in Du Rietz 1931). Raunkiaer responded by saying that no reason was evident to believe that the life-form spectrum would be altered by the presence of alien species, as most of these species would have emigrated from an area with a similar phytoclimate (Raunkiaer 1934). Data from this study, and the little information that could be gleaned from the literature show a noteworthy trend (Table 4). In all of these spectra the percent of therophyte species is much higher than would be expected from the hemicryptophytic phytoclimate. Apparently environmental and/or human disturbance can and does have a significant impact on the life-form spectrum, or more importantly, on the “survival strategy” of these species.

One potential problem to the method used to produce the life-form spectra in the development of this paper, and other papers, involves the concept of species

TABLE 4: Life-form spectra for alien species in selected geographic regions of North America.

Region	Sp	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat	37	2.7	2.7	43.2	2.7	48.7
Indiana	272	7.7	3.3	40.1	7.4	41.5
(McDonald 1937)						
Kentucky	226	7.1	1.3	41.6	4.9	45.1
(Gibson 1961)						
Connecticut	169	12.4	3.6	46.7	8.3	29.0
(Ennis 1928)						
Bull Run Mountain,						
Virginia	133	12.0	0.0	52.6	6.8	29.3
(Allard 1944)						

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
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(After Raunkiaer 1934)

importance. In producing the spectrum, all species are given equal “weight” as to their importance in the community, even though some are represented by one individual on the entire mudflat, whereas others have thousands of individuals in the same location. Therefore, it may be argued that these data have no real ecological significance. The abundance values of the species determined for this mudflat are in some respects arbitrary, but they do provide at least an approximate indication of the ecological importance of each species. The results of the two spectra produced using these abundance data have been compared to the other life-form spectra determined for this mudflat habitat (Table 5). It seems that the alternate methods have not substantially changed the life-form spectrum from the original, more traditional method. The therophyte and hemicryptophyte components remain the most important, and the approximate percentages of each remain virtually constant, regardless of whether or not abundance values are used when determining the life-form spectrum.

CONCLUSION

Examination of the life-form spectrum on a recently exposed river mudflat has produced some noteworthy results. The spectrum gives some indication as to the level of protection individual species must “provide” for their perennating buds to insure survival through the least favorable environmental conditions. It is evident from previous life-form studies that the general climatic conditions in a

TABLE 5: Life-form spectra for the Scioto River mudflat using various methods.

Region	Sp #	PH	CH	HE	CR	TH
Normal Spectrum (Raunkiaer 1934)	400	46.0	9.0	26.0	6.0	13.0
Scioto River Mudflat –all species	127	6.3	1.6	41.7	10.2	40.2
Scioto River Mudflat –native species	90	7.8	1.1	41.1	13.3	36.7
Scioto River Mudflat –alien species	37	2.7	2.7	43.2	2.7	48.7
Scioto River Mudflat –Common or Abundant species	42	2.4	0.0	45.2	7.1	45.2
Scioto River Mudflat –all species, “weighted” (based on abundance values)	127	5.2	1.2	42.3	8.4	42.3

PH (Phanerophytes) = Perennating buds on shoots in the air at least 25 cm above the soil surface.
CH (Chamaephytes) = Perennating buds above the soil surface but less than 25 cm high.
HE (Hemicryptophytes) = Perennating buds at soil surface, usually covered by snow or organic matter during winter.
CR (Cryptophytes) = Perennating buds protected below soil surface or under water.
TH (Therophytes) = Annual plants, which survive unfavorable conditions as seed.
(After Raunkiaer 1934)

geographic region have a major role in the floristic composition of that region. The Scioto River mudflat flora in central Ohio also appears to have been produced with similar environmental constraints. Hemicryptophytes comprise the major component of the life-form spectrum for this site, which was to be expected as this mudflat is located in the phytoclimate where hemicryptophytes normally predominate. The exceedingly high percentage of therophytes in this life-form spectrum was unexpected, however, and suggests that other, more localized environmental factors (e.g., annual flooding) may have a significant role in the life-forms present in certain habitats.

The presence of non-indigenous species also appears to have an impact on the life-form spectra as determined for floras of state-wide geographic regions. These alien species are more evident in small areas of severe disturbance, and the alien floristic components have a higher percentage of therophytes in their life-form spectra than has otherwise been reported for broader regions.

Altering the traditional method for calculating life-form spectra to include species abundance data did not significantly change the percentages of these mudflat species in each of the five life-form categories.

APPENDIX I. Plant species on newly exposed mudflat of the Scioto River, Delaware County, Ohio—September/December 1990.

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
<i>Abutilon theophrasti</i>	TH	A	R	UPL
<i>Acer negundo</i>	PH	N	O	FAC+
<i>Acer saccharinum</i>	PH	N	R	FACW
<i>Acorus americanus</i> (<i>A. calamus</i>)	CR	N	R	OBL
<i>Alisma plantago-aquatica</i>	CR	N	C	OBL
<i>Amaranthus albus</i>	TH	N	R	FACU
<i>Amaranthus tuberculatus</i>	TH	N	A	FACW
<i>Ambrosia trifida</i>	TH	N	R	FAC
<i>Ammannia robusta</i> ¹	TH	N	O	OBL
<i>Artemisia annua</i>	TH	A	O	FACU
<i>Asclepias incarnata</i>	HE	N	O	OBL
<i>Aster simplex</i>	HE	N	A	FACW
<i>Atriplex patula</i>	TH	N	O	FACW
<i>Bidens cernuus</i> ²	TH	N	C	OBL
<i>Bidens connatus</i>	TH	N	O	FACW+
<i>Bidens frondosus</i>	TH	N	C	FACW
<i>Bidens tripartitus</i> (<i>B. comosus</i>)	TH	N	C	FACW
<i>Capsella bursa-pastoris</i>	TH	A	R	FACU
<i>Chenopodium album</i>	TH	A	O	FACU+
<i>Chenopodium ambrosioides</i>	HE	A	R	FACU
<i>Chenopodium bushianum</i>	TH	N	R	UPL
<i>Convolvulus arvensis</i>	CR	A	R	UPL
<i>Conyza canadensis</i>	TH	N	R	UPL
<i>Cuscuta gronovii</i>	TH	N	O	UPL
<i>Cyperus aristatus</i> (<i>C. inflexus</i>)	TH	N	C	FACW+
<i>Cyperus erythrorhizos</i>	TH	N	R	FACW+
<i>Cyperus esculentus</i>	CR	N	R	FACW
<i>Cyperus odoratus</i> (<i>C. ferruginescens</i>)	TH	N	O	FACW
<i>Cyperus rivularis</i>	TH	N	R	FACW+
<i>Cyperus strigosus</i>	CR	N	C	FACW
<i>Daucus carota</i>	HE	A	R	UPL
<i>Dichanthelium clandestinum</i> (<i>Panicum clandestinum</i>)	HE	N	R	FAC+
<i>Digitaria ciliaris</i> (<i>D. sanguinalis</i>)	TH	A	R	FACU-
<i>Dipsacus fullonum</i> (<i>D. sylvestris</i>)	HE	A	O	UPL
<i>Echinochloa muricata</i> (<i>E. pungens</i>)	TH	N	O	FACW+
<i>Echinocystis lobata</i>	TH	N	R	FAC
<i>Eclipta prostrata</i> (<i>E. alba</i>)	TH	N	C	FAC
<i>Eleocharis intermedia</i>	TH	N	R	FACW+
<i>Eleocharis obtusa</i>	TH	N	C	OBL
<i>Eleusine indica</i>	TH	A	R	FACU-
<i>Epilobium coloratum</i>	HE	N	R	OBL

(Appendix I continued)

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
<i>Eragrostis hypnoides</i>	TH	N	A	OBL
<i>Erigeron philadelphicus</i>	HE	N	C	FACU
<i>Eupatorium perfoliatum</i>	HE	N	O	FACW+
<i>Galinsoga quadriradiata</i> (<i>G. ciliata</i>)	TH	A	O	UPL
<i>Glechoma hederacea</i>	HE	A	R	FACU
<i>Gleditsia triacanthos</i>	PH	N	O	FAC-
<i>Gratiola neglecta</i>	TH	N	R	OBL
<i>Helenium autumnale</i>	HE	N	C	FACW+
<i>Hibiscus laevis</i> (<i>H. militaris</i>)	HE	N	O	FACW+
<i>Hibiscus trionum</i>	TH	A	O	UPL
<i>Impatiens capensis</i>	TH	N	O	FACW
<i>Juncus effusus</i>	HE	N	R	FACW+
<i>Juncus tenuis</i>	HE	N	C	FAC-
<i>Justicia americana</i>	CR	N	R	OBL
<i>Leersia oryzoides</i>	HE	N	O	OBL
<i>Leersia virginica</i>	HE	N	R	FACW
<i>Leonurus marrubiastrum</i>	HE	A	R	UPL
<i>Lindernia dubia</i>	TH	N	C	OBL
<i>Lobelia siphilitica</i>	HE	N	R	FACW+
<i>Ludwigia palustris</i>	HE	N	C	OBL
<i>Lycopus americanus</i>	HE	N	C	OBL
<i>Lycopus x sherardii</i>	HE	N	R	OBL
<i>Lycopus uniflorus</i>	HE	N	O	OBL
<i>Lycopus virginicus</i>	HE	N	R	OBL
<i>Lysimachia nummularia</i>	CH	A	O	OBL
<i>Malva neglecta</i>	HE	A	C	UPL
<i>Melilotus</i> sp.	HE	A	R	FACU
<i>Mentha arvensis</i>	HE	N	C	FACW
<i>Mimulus alatus</i>	HE	N	O	OBL
<i>Mimulus ringens</i>	HE	N	A	OBL
<i>M. ringens</i> x <i>M. alatus</i>	HE	N	R	OBL
<i>Mollugo verticillata</i>	TH	A	R	FAC
<i>Morus alba</i>	PH	A	R	FACU
<i>Oxalis stricta</i>	HE	N	R	UPL
<i>Panicum dichotomiflorum</i>	TH	N	R	FACW-
<i>Penthorum sedoides</i>	HE	N	A	OBL
<i>Phalaris arundinacea</i>	CR	N	C	FACW+
<i>Phyla lanceolata</i> (<i>Lippia lanceolata</i>)	HE	N	C	OBL
<i>Physostegia virginiana</i>	HE	N	R	FAC+
<i>Pilea pumila</i>	TH	N	O	FACW
<i>Plantago lanceolata</i>	HE	A	R	UPL
<i>Plantago major</i>	HE	A	C	FACU
<i>Plantago rugelii</i>	HE	N	R	FACU
<i>Polygonum aviculare</i>	TH	A	R	FACU
<i>Polygonum hydropiper</i>	TH	N	C	OBL
<i>Polygonum lapathifolium</i>	TH	N	A	FACW+
<i>Polygonum pensylvanicum</i>	TH	N	A	FACW
<i>Polygonum persicaria</i>	TH	A	C	FACW

(Appendex I continued)

Scientific Name	Life-Form	Native or Alien	Abundance	Habitat Classification
Polygonum punctatum	TH	N	C	OBL
Populus deltoides	PH	N	C	FAC
Portulaca oleracea	TH	A	C	FAC
Potentilla norvegica	HE	A	C	FACU
Ranunculus sceleratus	TH	N	C	OBL
Rorippa palustris	HE	N	C	OBL
Rorippa sylvestris	HE	A	R	FACW
Rudbeckia laciniata	HE	N	O	FACW
Rudbeckia triloba	HE	N	R	FACU
Rumex crispus	HE	A	C	FACU
Rumex obtusifolius	HE	A	R	FACU-
Rumex verticillatus	HE	N	O	OBL
Sagittaria latifolia	CR	N	O	OBL
Salix discolor	PH	N	R	FACW
Salix exigua (<i>S. interior</i>)	PH	N	O	OBL
Salix nigra	PH	N	R	FACW+
Samolus valerandi (<i>S. parviflorus</i>)	HE	N	C	OBL
Saururus cernuus	CR	N	R	OBL
Scirpus pungens (<i>S. americanus</i>)	CR	N	R	OBL
Scirpus tabernaemontani (<i>S. validus</i>)	CR	N	R	OBL
Scrophularia marilandica	HE	N	R	FACU-
Scutellaria lateriflora	HE	N	O	FACW+
Setaria glauca	TH	A	R	FAC
Setaria viridis	TH	A	R	UPL
Sida spinosa	TH	A	R	UPL
Solanum nigrum	TH	A	C	FACU-
Solidago canadensis	HE	N	C	FACU
Sonchus asper	TH	A	O	FAC
Stachys palustris	CR	N	R	OBL
Trifolium pratense	HE	A	R	FACU-
Typha latifolia	CR	N	O	OBL
Urtica dioica	HE	A	C	FACU
Verbascum thapsus	HE	A	O	UPL
Verbena hastata	HE	N	C	FACW+
Verbena urticifolia	HE	N	O	FACU
Veronica catenata	CH	N	R	OBL
Veronica peregrina	TH	N	C	FACU-
Xanthium strumarium	TH	A	C	FAC

¹Following the treatment of S.A. Graham (Taxon 28:169 – 178. 1979).
²We have used the -us endings for the epithets in *Bidens*, according to E.G. Voss (Michigan Botanist 16:138. 1977).
A (Abundant) = Species extremely numerous; considered a dominant species in some part of the community.
C (Common) = Many individuals scattered throughout mudflat community.
O (Occasional) = A few individuals present on mudflat (more than 5).
R (Rare) = 1 to 5 individuals present on mudflat.

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